S&E SCIENCE AND THE ENVIRONMENT BULLETIN S&E
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CONSERVING CANADA'S DEEP SOUTH

Wild magnolias laden with orange and green blossoms, spicy sassafras trees, pawpaws, prickly pear cactuses, opossums and flying squirrels may sound more at home in a story by Mark Twain than Farley Mowat. But these southern species also make their homes in a tiny but temperate region of southwestern Ontario known as Carolinian Canada.

Comprising the northernmost edge of the deciduous forest region in eastern North America, the Carolinian zone is the region of Ontario roughly south of an imaginary line between Grand Bend and Toronto. Not surprising for an area that dips, in places, to the same latitude as northern California, Carolinian Canada boasts warmer temperatures year-round and fewer days of frost than any other part of Ontario. Although it makes up only one per cent of Canada's total land area, its accommodating climate gives it more species of flora and fauna than any other ecosystem in the country—some of which are common in the Carolinas and the Mississippi basin.

Of all the vulnerable, threatened and endangered species in Canada, 65 per cent occur in this region, and nearly 25 per cent are found nowhere else in the country. Among its many unique residents is the Eastern hognose snake, which, if its cobra-like display fails to frighten intruders, simply rolls over and plays dead. Others include a slow-moving marsupial called the Virginia opossum, the leathery Eastern spiny softshell turtle, the Carolina wren and rare trees like the tulip, sycamore and American chestnut.

Science and Habitat Conservation

This is the second in a series of articles on the role of Environment Canada's science in conserving important habitats across Canada. In this issue we profile efforts in the unique Carolinian region of southwestern Ontario.

Unfortunately, the pressures of human development pose a significant threat to this biodiversity. Twenty-five per cent of Canada's population resides in the area, and 73 per cent of the land in the region is now used for agriculture. Carolinian forests used to cover well over 80 per cent of the region and now occupy only 11, with deep woods only half a per cent of the landscape. Forest fragmentation in the region is more serious than anywhere else in Ontario, and increasing rapidly.

A traditional inhabitant of the southeastern United States, the Virginia opossum is becoming well established within the Carolinian zone and even beyond in Canada.

Wetlands have dropped from 28 per cent of the landscape to five per cent, and only 0.06 per cent of the original tallgrass prairie and 0.02 per cent of the oak savanna remain.

In 1984, a group of government agencies and non-government conservation groups formed the Carolinian Canada Program to promote the conservation of these remaining natural landscapes. Since then, the Program has successfully protected 38 priority areas through the public acquisition of lands and a ground-breaking voluntary private landowners stewardship program.

A wide range of other projects also contribute to habitat conservation in

The Carolinian region of southwestern Ontario

the Carolinian zone—from land restoration and naturalization programs carried out by local conservation authorities to the protection of habitats designated as national or provincial parks, National Wildlife Areas, and Areas of Natural and Scientific Importance. Another significant step was taken in July of this year, when the Nature Conservancy of Canada purchased Middle Island—a rich Carolinian ecosystem and Canada's southernmost site—for $1.3 million. The 18-hectare island, which is home to 10 per cent of the world's Lake Erie water snakes and a variety of other rare plant and animal species, will be managed in conjunction with Point Pelee National Park as a nature sanctuary and living museum for scientific research.

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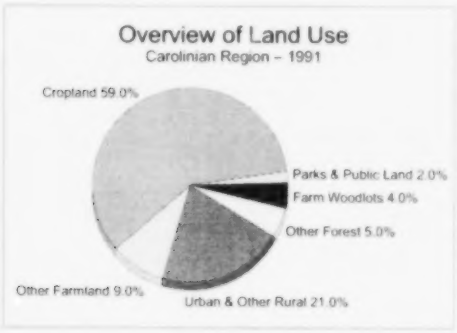
Environment Canada's involvement in habitat conservation in Carolinian Canada spans a wide range of activities. The Great Lakes Wetlands Conservation Action Plan, in which the Department is a major partner, plays an important role in the protection of high-quality wetlands and the restoration of degraded wetland areas, particularly along the coastal areas of the lower Great Lakes basin. Remedial action plans are being implemented for six Areas of Concern in the Carolinian region—St. Clair River, Detroit River, Wheatley Harbour on Lake Erie, Niagara River, Hamilton Harbour and Toronto—that include habitat restoration projects funded through the Great Lakes 2000 Cleanup Fund. One such effort is currently under way at Cootes Paradise in Hamilton, where a concrete and steel barrier designed to keep destructive carp out of the marsh has resulted in a significant rebound in vegetation and the populations of species that rely on it. Environment Canada also contributes to community-led restoration efforts through its EcoAction 2000 funding program.

To control the impact of human use on essential habitats, nearly 6 000 hectares of land in the Carolinian zone are managed by the federal government. One area is Point Pelee National Park, southeast of Windsor, a world-renowned bird-watchers mecca and a gathering point for monarch butterflies during their annual migration south. The other four are National Wildlife Areas (NWAs) where Environment Canada managers determine which uses of the landscape are to be permitted, and where and how to make improvements to the habitat.



Long Point NWA—located on a narrow spit of land that juts into Lake Erie—is part of the largest sandspit-marsh complex on the Great Lakes, and one of Canada's most important and fragile areas. Also recognized as a Wetland of International Importance under the Ramsar Convention and a World Biosphere Reserve by the United Nations, its sheltered bays and marshes are renowned waterfowl staging areas. The wetlands of Big Creek NWA, at the base of Long Point, are an important component of this complex. Though much reduced in size by the drainage of land for agricultural use, St. Clair NWA, at the southern tip of Lake St. Clair, remains part of the most significant waterfowl staging area in Ontario south of James Bay and is also a Ramsar site. The marshes and shallow waters in the area are stopovers for hundreds of thousands of ducks, geese and swans during spring and fall migration.

The flower of the tulip tree. This wild magnolia species is eastern North America's tallest hardwood.

Environment Canada is also active in the recovery of endangered species in the Carolinian region—both as a member of multi-stakeholder recovery teams and through funding support—and is currently involved in efforts to restore and protect the king rail, prothonotary warbler, hooded warbler and Acadian flycatcher. As part of a joint recovery effort for the latter two species of birds, the Department is working with the Ontario Ministry of Natural Resources to improve the woodlot management practices of private land-owners by collecting data on the effects of diameter cuts and more sustainable, selective cuts on the birds that inhabit the area.

Another innovative effort is being undertaken at Pelee Island, where the Department is developing a unique ecosystem conservation program. This working landscape, where agricultural and wine-making activities are already present and more commercial development threatens, is home to more than 20 nationally listed plant and animal species at risk. Last spring, scientists began three years of field sampling to determine the rate of loss of local plant populations and how they are affected by landscape changes and other human impacts. By working on a broad-scale recovery plan for the entire ecosystem—instead of focusing on individual species—they are hoping to develop a more integrated model that can eventually be applied to other sites across the country.

With only two per cent of the Carolinian region's natural habitat under public ownership, the need for a more community-oriented program resulted in the development of *A Conservation Strategy for Carolinian Canada* in 1997. Aimed at protecting and restoring biodiversity in the region, the report provides guidance to the many groups involved in habitat conservation—including federal, provincial, regional and municipal governments, non-government organizations, First Nations communities, conservation authorities, private landowners, scientists, academic institutions, industry and the general public.

The Carolinian Canada Coalition, created as a result of this Strategy, is made up of representatives from each of these groups, including Environment Canada. A member of the Coalition's management committee, the Department is currently involved in a Big Picture Project to pull together data on specific species and ecological communities across the region and map this information for use in municipal planning. The next step of the project will be to determine ways to link up isolated natural areas through ecological means, such as reforestation, the revegetation of shorelines, and the creation of wildlife corridors. These new connections will not only help species in the area cope with the impacts of human development, but also enable them to adapt more easily to the effects of climate change on this unique and fragile habitat. S&E

PUMPING SOY

It may be hard to imagine pulling up to the pumps at your local gas station and asking the attendant to "fill it up with soy." But a family of fuels called biodiesels is making it possible for internal combustion engines to run on mixtures containing compounds made from renewable biomass.

A soybean plant.

Biodiesels are diesel fuels that have been blended with fatty acids or alkyl esters, which are formed by mixing vegetable oils or animal fats with an alcohol such as methanol or ethanol. Although biodiesels made from canola and rapeseed oil are fairly common, recent attention has focused on another hardy, high-yield species: the soybean.

The use of soybean-based biodiesels is already fairly widespread in areas of the United States where plant production is sufficient to meet commercial needs. As part of the effort to determine its potential here in Canada, Environment Canada, Health Canada and the Ontario Soybean Growers Marketing Board have been working together to determine how tailpipe emissions from this plant-based fuel compare to those of other more conventional types, such as gasoline and diesel fuel.

Testing was carried out at Environment Canada's Environmental Technology Centre in Ottawa, on a light-duty truck equipped with a 5.9-litre, 24-valve turbo diesel engine and an oxidation catalyst. Baseline tests were conducted using a commercially available low-sulphur diesel fuel, then the biodiesel tests were done with various percentage blends of methyl soyate and conventional diesel. The tests were run at two standard temperatures—one at room temperature and the other in a cold cell that simulated the effects of a typical Canadian winter.

The tests determined that, at these temperatures, emissions from biodiesel blends and low-sulphur diesel fuel differed very little—likely because the oxidation catalysts found on modern cars are so effective at reducing pollutant emissions. However, it was found that hydrocarbon emissions were lower in all biodiesel tests, and seem to be related to the amount of methyl ester in the blend. These results could indicate that the catalytic converter is more efficient at converting the hydrocarbons in biodiesel exhaust than in diesel exhaust. Since hydrocarbons include a family of pollutants that can affect the environment and human health, this finding could be important.

The most interesting result, however, came from the tests done for particulates—tiny, microscopic particles found in the emissions of burned fossil fuels, the smaller of which can be inhaled deeply into the lungs and are implicated in a variety of respiratory problems. They revealed that, in a typical low-sulphur diesel fuel, 100 per cent of the particulate matter is of inhalable size—that is, 2.5 microns or less in diameter. With methyl soyate, on the other hand, the figure is closer to 60 per cent—meaning that widespread use of biodiesels could result in a 40-per-cent reduction in the fine particulate emissions that are a significant health concern.

While it isn't likely that biodiesels will ever completely replace fossil fuels, efforts will continue to make them more efficient and clean-burning. Now available in small quantities in Canada, and in larger quantities in the United States, further advancements in biodiesels will help reduce dependency on fossil fuels. The result could be fewer emissions from transportation sources that affect both climate change and clean air. S&E

Fuel	Test	Phase of Test	Carbon Monoxide	Carbon Dioxide	Nitrous Oxides	Total Hydrocarbons
Low-Sulphur Diesel	Cold Start	1	2.97	885	15.51	0.28
		2	3.31	772	10.52	0.30
	Hot Start	1	1.64	612	7.36	0.16
		2	2.14	703	9.20	0.24
Methyl Soyate	Cold Start	1	2.36	784	11.73	0.27
		2	1.86	687	8.61	0.17
	Hot Start	1	1.10	595	6.54	0.10
		2	1.46	657	8.01	0.14

Averaged emission rates compared between low-sulphur diesel and the mid-range methyl soyate–fueled testing at engine-started cold, and testing of warmed-up engine. Measurements are at 0°C and in grams per mile.

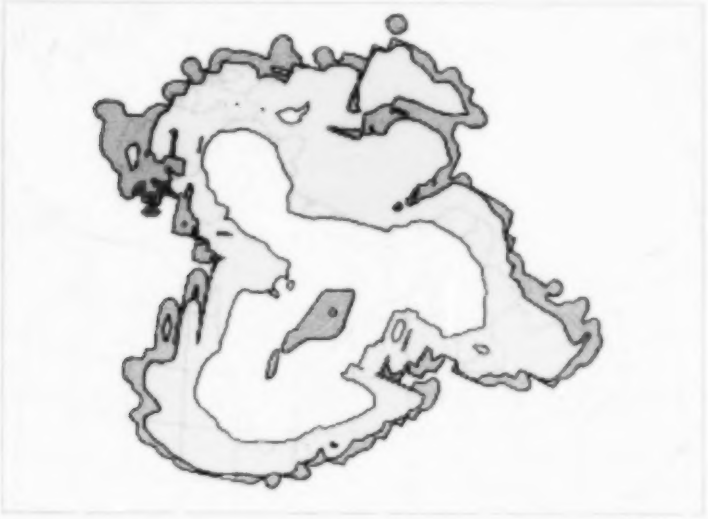
THE TELLTALE CLOUD

Deep beneath the earth's surface, a muffled roar and waves of vibrations signal the release of a radioactive cloud into the air. Using atmospheric modeling, scientists know not only exactly where the cloud is, but also where it is going.

The ability to perform such sophisticated atmospheric modeling has made Environment Canada's Canadian Meteorological Centre in Montréal a key player in the verification of the Comprehensive Nuclear Test Ban Treaty—a landmark agreement that commits countries around the world to refrain from conducting nuclear weapon explosion tests. The Treaty is due to come into effect in the early 2000s, and although it has already been signed by all declared nuclear-weapon states, these verification procedures are being put in place to deter any clandestine testing. Natural Resources Canada and Health Canada also play an important role in the verification process through the operation of seismic, hydroacoustic and radionuclide monitoring stations

Computer modeling of the atmosphere forms the basis of Environment Canada's weather forecasts, and is also used to predict the transport and dispersion of airborne materials. Developed in the wake of the 1986 nuclear accident at Chernobyl, this advanced technology has many and varied applications including the support of safe aircraft operations, such as forecasts of volcanic ash clouds travelling around the earth following an eruption.

In the case of a nuclear explosion, computer models can estimate the time it takes for radioactive material to move from an explosion site through the atmosphere to different regions of the globe. The path of the nuclear cloud can then be mapped based on the speed of atmospheric motion. Depending on the location of the explosion and the particular atmospheric patterns, it can take up to 10 days before radioactive material is detected by ground-based monitoring systems—although the search is made easier by the unique atmospheric "signature" of the cloud.



Modeling map showing atmospheric transport of a nuclear cloud from an unconfirmed release. Gradations of colour on map indicate different degrees of radioactivity.

Although the fact that radioactivity is not always vented into the atmosphere can make nuclear test verification more difficult, the seismic activity caused by a nuclear explosion is very different from that of an earthquake or other natural rumble. Environment Canada's Atmospheric Transport Model is valuable because it can be used—in conjunction with monitoring of seismic activity and the presence of radionuclides in the air—in three verification-related scenarios, including one where an event is only suspected and no cloud has been emitted.

This application, known as backward modeling, uses data on non-conventional radioactive materials collected by radionuclide samplers to track the origin of a nuclear cloud based on possible explosion sites. In forward modeling, it predicts the direction and flow of radionuclides from a suspected event and the type and location of sampling equipment that could be used to detect them. Where both the time and location of an event are known, the model predicts where the nuclear cloud will travel and helps to identify the explosive yield of the nuclear device.

The use of atmospheric modeling to detect and track radioactive material is just one example of how meteorological technology is being expanded for use in a variety of fields. This application not only assists humankind in its pursuit of peace, but also increases preparedness in the case of nuclear-reactor accidents and other large-scale toxic releases, and promotes the free and open exchange of meteorological data and products within the international community. S&E

QUENCHING THE PEACE ATHABASCA DELTA

The Peace Athabasca Delta in northern Alberta is one of the world's largest inland freshwater deltas, and a wetland of international importance under the Ramsar Convention. Home to some of the largest undisturbed grass and sedge meadows in North America, it provides habitat for large populations of waterfowl, muskrat, beaver and free-ranging wood bison.

The Peace Athabasca Delta

Over the past 25 years, however, this complex and dynamic region has undergone several prolonged dry periods that have turned some basins from aquatic into terrestrial ecosystems. The first came after the construction and initial filling of the W.A.C. Bennett hydroelectric dam at the headwaters of the Peace River, between 1968 and 1971, and the second after the retreat of a major spring flood in 1974. Scientists at Environment Canada's National Water Research Institute investigated these trends, and found that the effects of flow regulation, combined with variations in climate, had reduced the number of massive ice jams that cause flooding.

Unlike urbanized areas to the south, where spring flooding caused by river ice jams often wreaks havoc on property and the economy, flooding in this remote northern part of Canada spurs the high biological productivity for which the Delta is famous. Flooding is vital, especially to the perched ponds and lakes that are separated from the open-water channel system. Without it, all sorts of changes occur to the ecosystem, from shifts in dominant vegetation to dramatic declines in small-mammal habitats and populations.

Knowing why these drying periods occurred has enabled scientists to develop a strategy that maximizes the potential for flooding by timing flow releases from the dam to coincide with favourable natural conditions, such as the size of the snowpack. In spring 1996, hydrological and climatic conditions were appropriate, and a timed flow release by dam managers increased the magnitude of an ice-jam flood—bringing water to areas that had been dry for more than two decades.

These images — taken at the same location one month apart — show the extreme differences in water levels in the Peace Athabasca Delta before and after flooding.

There is still much to be learned about the hydro-climatology and ecology of the Delta if the region's productivity and biological diversity are to be sustained. However, gathering information about such a huge and remote region poses many problems for researchers. To meet these challenges, Environment Canada scientists are developing innovative tools to learn more about the spatial dimension of floods, water levels and changing flow regimes in the region.

One such tool is satellite imagery. During the years when the Delta was drying out, willow grew extensively, contributing to a thick cover of vegetation that could not be penetrated by traditional remote-sensing methods. Using a combination of traditional satellite technology and the newer RADARSAT microwave system, scientists have been able to "see" through this cover and track the boundaries of the 1996 flood.

Analysis of historical satellite imagery showing past water-level fluctuations will further improve understanding of evapotranspiration and other hydrological processes, and provide data for water-balance models that help predict future changes. These

models, along with a hydraulic model of the region, are now being applied in ongoing research into the potential impacts of climate change on water resources in this unique and important region of the country. S&E

THE EARTH FOR STORING ENERGY

Like a giant Thermos bottle, the earth has remarkable insulating properties that enable it to maintain temperatures underground for extended periods of time. Environment Canada is applying this unique capability to store available, surplus energy—such as seasonal temperatures and waste heat from mechanical processes—for heating and cooling buildings.

Underground thermal energy storage (UTES) uses permeable, water-bearing rock formations called aquifers—or, where aquifers are unavailable, a network of plastic tubing inserted into boreholes drilled into the earth—as underground storage areas for water. With the aquifer system, two well fields are tapped: one for cold storage and the other for heat. These wells, which are usually around 200 metres deep, are capable of maintaining storage temperatures of between 4 and 90 degrees Celsius.

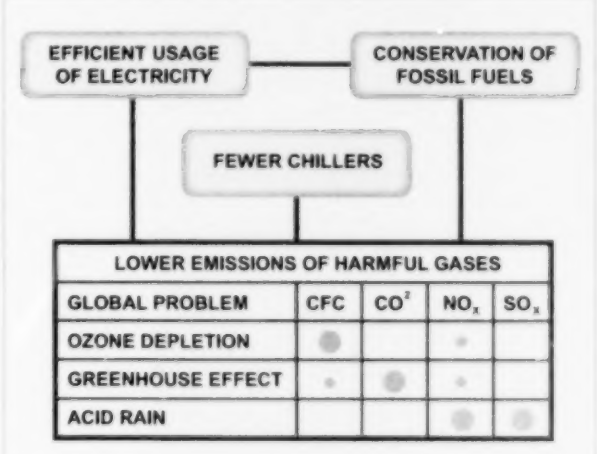
During the summer months, cool groundwater is extracted from one aquifer and circulated through building systems to lower the air temperature. The water, which is heated during the process, is then returned to the other aquifer for use in heating that winter—a cyclic process that can be repeated indefinitely. A UTES system typically reduces cooling costs by 80 per cent and heating costs by 40 per cent or more. And, because it is a clean technology, it means a significant reduction in emissions of greenhouse gases and ozone-depleting substances.

Environment Canada in the Atlantic region has developed a variety of tools and procedures for implementing this energy-efficient technology—including tests to determine the thermal properties of boreholes, water treatment technologies for high-temperature applications, and environmental screening techniques—and plays an active role in the transfer of UTES technologies, both nationally and internationally.

Four years ago, the Department teamed up with the New Brunswick Department of the Environment, New Brunswick Power, the Canadian Electricity Association, the Panel of Energy Research and Development, and the local community to launch an aquifer-based UTES demonstration project at the Sussex Hospital in New Brunswick. The first hospital in Canada and the second in North America to adopt such a system, it has saved nearly $50 000 a year in energy consumption costs since the project began, and reduced its carbon dioxide emissions by 720 000 kilograms annually. These savings were accomplished after the hospital had already cut its energy consumption in half by installing an energy management system. The UTES system is also playing a significant role in Year 2000 compliance, because during an emergency, only small auxiliary generators are required to operate the water pumps used in heating and cooling.

Underground thermal energy storage is commonly used in China and parts of western Europe—particularly the Netherlands and Sweden, where it is growing by 25 per cent a year. Although office buildings remain the primary market for the technology, it is gaining ground in industrial and agricultural applications, and a new market is developing in the de-icing and cooling of roads and bridges.

In Canada, the example set by the Sussex Hospital and other successful UTES projects, such as the Saskatoon Airport and Carleton University in Ottawa, has spurred the development of several new initiatives in Ontario, Nova Scotia and British Columbia. The many other instances where a system of this kind could be implemented hold the potential for considerable long-term environmental benefits, and a reduction in our heavy usage of fossil fuels for heating and electricity. S•E



Schematic showing the environmental benefits of underground thermal energy storage. Circles represent the relative impact of the use of UTES technology on emissions that contribute to these global problems.

BOLSTERING THE BANKS OF THE ST. LAWRENCE

Waves caused by wind and passing ships, fluctuations in water level, ice and currents are eating away the banks of the St. Lawrence River, with some areas receding at a rate of up to three metres a year. Environment Canada scientists are working to identify, stabilize and restore the most threatened areas before they disappear and, in the process, to preserve vital bird and wildlife habitat along the river's edge.

Studies conducted three years ago by Environment Canada and its partners under the St. Lawrence Vision 2000 program were the first to precisely document the magnitude of the problem along the length of the waterway. Using recent surveys and historical aerial photographs, they discovered that 25 per cent of the 1 500 kilometres of shoreline between Cornwall and Quebec City show signs of active erosion. It is estimated that 2 000 hectares of habitat have been lost since the 1960s, when unusually high water levels weakened the integrity of the banks.

Most profoundly affected is the area between Montreal and Lac Saint-Pierre, west of Trois-Rivieres, where 50 per cent of the shoreline is receding and an estimated 1 500 hectares of island shore habitat have been lost. The problem is due, in part, to the fact that this stretch of the river is relatively narrow, and the shoreline is therefore in closer proximity to the shipping lane, which sees more than 15 000 passages a year. The region also has almost three times as many islands as other parts of the river, so more shoreline is affected.

Although erosion is a natural process, its rapid acceleration—caused, in part by human activity—threatens to destroy important nesting sites for waterfowl and spawning areas for fish, and could affect other bank-dwelling wildlife such as muskrats, frogs, turtles and songbirds. While some shorelines have been stabilized using inert concrete and stone embankments in the past, these inert methods do not favour vegetation growth, and the resulting shoreline has little ecological or aesthetic value.

To address the problem, Environment Canada has piloted several natural restoration techniques at key sites along the St. Lawrence. One is Îles de la Paix National Wildlife Area, on the south shore of Montreal in Lac Saint-Louis. Home to a dozen threatened or vulnerable species, this sensitive 50-hectare archipelago is losing its shoreline at a rate of 2.2 hectares per year, a clip that could erase it from the map within 20 years.

In an effort to slow the process and reverse existing damage, scientists tried stabilizing an embankment by filling horizontal trenches with rock-filled metal baskets (gabions) and bundles of branches, covering the area with branch mats topped with wire mesh, adding earth and then planting trees and other vegetation. Although the method met with some success, water destroyed some of the lower-lying vegetation and degraded the gabions, enabling some of the rocks to wash away. A similar approach, using larger rocks, was employed successfully at nearby Varennes—one of the most important waterfowl nesting grounds on the St. Lawrence.

A different technique was tested at Îles de Contrecoeur National Wildlife Area, east of Montreal, where barriers formed by material that was dredged during the deepening of the waterway are rapidly eroding and exposing the string of 27 smaller islands to the ravages of the river. Rows of cedar logs and branch bundles were used to shore an eroding embankment and the area was covered with earth and living shrubs. The method was later revised to bring the logs nearer to the base of the embankment.

A fourth project attempted to introduce vegetation to 100 metres of stone-lined embankment on the Beauport Strands, east of Quebec City, to determine whether or not the many existing areas of this type can be restored to useful production. By filling spaces between the rocks with different types of mulch and planting various species of seedlings, scientists determined that bark mulch was less prone to sifting down through the rocks than shredded leaves or branch shavings were, and that Canadian alder was the most hardy candidate for such plantings—with a 50-per-cent survival rate. Pebbles were recommended to further reduce the problem of the mulch washing out from below.

Over the past two years, Environment Canada has financed 71 stabilization projects along the St. Lawrence, totalling $7.3 million, through its own EcoAction 2000 and the St. Lawrence Action Plan's Community Interaction programs—both of which promote community-based environmental efforts. With costs as high as $1 000 per metre for some shoreline restoration projects, scientists are now trying to determine exactly how rapidly each section of bank is eroding and the potential impact this will have on wildlife habitat. This work—which will take two to three years to complete—will be useful in determining priorities for future action in the effort to save the banks of the St. Lawrence. S&E

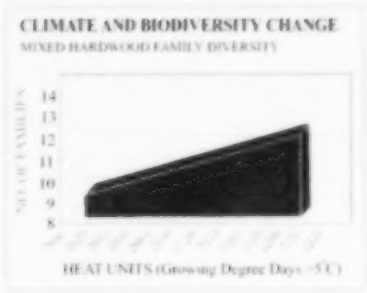
MAPS LINK ATMOSPHERE AND BIODIVERSITY

The atmosphere has a powerful influence on the biological world—affecting everything from the kinds of plants and animals that can live in certain regions to the economic activities we undertake in these landscapes. To learn more about these connections, scientists at Environment Canada are combining atmospheric maps of available heat, weather extremes and pollution with maps of land use and biodiversity.

The Integrated Mapping Assessment Project, launched in January 1999, involves collecting maps of certain areas of the country, superimposing them over one another—typically on a computer screen—and then analyzing and interpreting the spatial correlations. The maps are produced at various scales, from local to global, although the initial focus of the study has been on regions of Ontario, where a plethora of detailed, high-quality climate maps are already available. Using regional maps is also an important part of the project's goal of bringing national issues—such as climate change—to a level that municipal decision-makers can understand and take action on.

Although the project is still in its infancy, early mapping efforts have shown strong support for several scientific hypotheses—including the fact that available heat is a powerful trigger in the natural world, and a major influence on land use. Maps of land use that have been combined with those of available heat (expressed in corn heat units (CHUs) and growing degree days) have been used to show that the location, intensity and profitability of agriculture are affected by climate. For example, CHUs over 2800 and 3200, respectively, have been historically linked to the disappearance of wetlands and woodlots. This suggests that, particularly in rural areas, the degree or two of warming that is expected to take place over the next several years due to climate change will eliminate many natural habitats by making them more suitable to human economic activities—such as farming.

Integrated mapping has also been used to examine the connection between biodiversity and the atmosphere. One study, which used international biodiversity protocols, revealed a link between climate and the diversity and growth of forest species—a factor that could affect conservation practices in the future. Scientists are also exploring the possibility that, although a warmer landscape can support greater biodiversity, increases in species may come primarily from exotic or non-native species, similar to the invasions of zebra mussels and purple loosestrife.



This graph, based on information from an integrated map, illustrates the link between corn heat units and tree biodiversity.

Environment Canada is hoping to expand its work over the next several years to include other regions of the country and other atmospheric phenomena such as extreme weather events, frost, soil moisture, acid loading, ground-level ozone and other pollution. In January 2000, the Department will host a workshop on integrated mapping to encourage its partners—including government and non-government organizations, industry and academics—to create an integrated look at how communities function by adding their maps to the project and filling gaps in information. Understanding how atmosphere and biodiversity are connected will teach people much about the effects of climate change on local ecosystems, and give decision-makers the tools to minimize and adapt to these effects before it is too late. S&E

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